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Observations on the Chiroptera of Socotra Island, Republic of Yemen

Abstract - Few and limited studies have been conducted previously on the island of Socotra concerning its bat population. During the period August-September 2003, more than 20 days/nights of surveys were spent in the field in order to locate and identify occurring bats. Thanks to these surveys three species of bats have been identified by roost searching and mistnetting: *Rhinopoma hardwickii, Asellia tridens* and *Rhinolophus clivosus* (its first ever recorded sighting in Socotra).

Key words: bats, Socotra, Yemen, *Rhinopoma hardwickii, Asellia tridens, Rhinolophus clivosus.*

Riassunto - Osservazioni sulla chirotterofauna dell'Isola di Socotra (Repubblica dello Yemen).

Poche e limitate indagini di campo sono state condotte precedentemente sulla chirotterofauna dell'Isola di Socotra. Nel periodo agosto-settembre 2003 sono stati condotti circa 20 giorni/notti di missione sul campo allo scopo di individuare i rifugi e definire la composizione in specie della chirotterofauna dell'isola. Grazie a tali indagini, tre specie sono state identificate mediante ispezione dei rifugi e l'impiego di *mist-net*: *Rhinopoma hardwickii, Asellia tridens* e *Rhinolophus clivosus*. Per quest'ultima specie si tratta della prima segnalazione per Socotra.

Parole chiave: chirotteri, Socotra, Yemen, *Rhinopoma hardwickii, Asellia tridens, Rhinolophus clivosus.*

Introduction

The Socotra Archipelago, politically administered as a part of the Republic of Yemen, is situated in the north-western section of the Indian Ocean and comprises four islands: Socotra, Adb-el-kuri, Samha and Darsa. Socotra itself is about 120 by 40 km and covers an area of 3,625 km^2. The island is about 240 km from the nearest mainland (Somalia).

Socotra is composed of a basement complex of igneous and metamorphic rocks of Pre-Cambrian age overlaid by sedimentary rocks, mainly limestone and sandstone.

According to Wranik (1998) topographically the island can be divided into three main zones:

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1. The costal plains, varying considerably in width.
2. A limestone plateau, extending over most of the island and averaging 300 to 700 m in altitude.
3. The Hagger Mountains in the centre, rising up to a height of 1,519 m.

The climate is monsoonal. There are no exact figures available on the annual temperatures and rainfall. As far as is known, the mean annual temperatures vary between 28°C and 37°C, and the annual rainfall averages about 130-170 mm.

The island is sparsely vegetated and dominated by xeromorphic forms. The vegetation is more luxuriant only in sheltered valleys and higher mountain areas (Mies & Zimmer, 1993; Davis *et al.*, 1994; Mies *et al.* 1995; Alexander & Miller, 1996).

The composition and status of the Chiroptera in the Socotra Archipelago is unclear. The information available is limited, and the data was not collected to a preconceived plan. De Winton *et al.* (1903) recorded a specimen from Socotra Island for the first time as *Rhinopoma microphyllum,* although it was later correctly identified as *R. hardwickii* by Kock (1969). Wranik (1986) reports the capture of two *Asellia tridens* near Hadibo, and three male specimens of *Rhinopoma hardwickii* in the Diksam plateau. Wranik *et al.* (1991) report the morphometrical measurements of two *Asellia tridens* captured near Hadibo (probably the same two specimens of the previously cited work). Guichard (1992) captured two bats: one specimen of *Asellia tridens* and a subadult of "what was probably" *Pipistrellus bodenheimeri,* in the wadi palm groves of Suq, near Hadibo. The presence of *Pipistrellus bodenheimeri* in Socotra seems to be confirmed by Menu (1987).

The final report of the zoological multi-disciplinary expedition in 1999 to the Socotra Archipelago (Evans, 2000) strongly recommended a research effort in order to analyse the species structure, distribution and status of the local Chiroptera. The present study is conceived in order to contribute to this proposed research effort (Cesarini, 2003). We tried for the first time to realize an extensive monitoring of the bats present in the main island of the archipelago.

It is possible to summarise the objectives of the present study as follows:

- Locate new bat roosts and colonies.
- Verify the species composition and distribution of Socotran bat fauna.
- Collect data on population composition, morphological and ecological characteristics of the recorded species.

Materials and methods

Preliminarily, in order to obtain useful information for the field phase, we collected 35 standardized interviews (28 extension officers of the Socotra Conservation and Development Program, and 7 community representatives).

We visited 23 roosts, caves and other sites, from August 19 to September 17, 2003. Where we found bats, we attempted a sampling capture by mist-net outside the roost; when this was impossible due to local conditions, the capture was done using a hand-net.

For each captured individual we recorded the following information:

- Sex and reproductive status.

- Age (young, adult).
- Morphological measurements (forearm, 5th finger, body length, tail).
- Presence of external parasites.
- Individual notes.

The captured bats were released as soon as possible at the end of morphological analysis.

For species identification we followed Harrison & Bates (1991).

For each site we collected the following information:

- Total number of bats counted or estimated (minimum and maximum number).
- Temperature and humidity (using a digital device).
- Bat-related signs.
- Human-related signs.

We also took photographs from most of the visited sites and captured chiropterans; they are available in the Socotra National Museum's Photo Library.

Results

Site surveys

From 17 sites at which bats were found, the sampling capture was successful at 16, where the number of bats collected ranged from one to nine. Tab. 1 provides information on each site where we found bats, and Fig. 1 shows the distribution of the surveyed sites in the island.

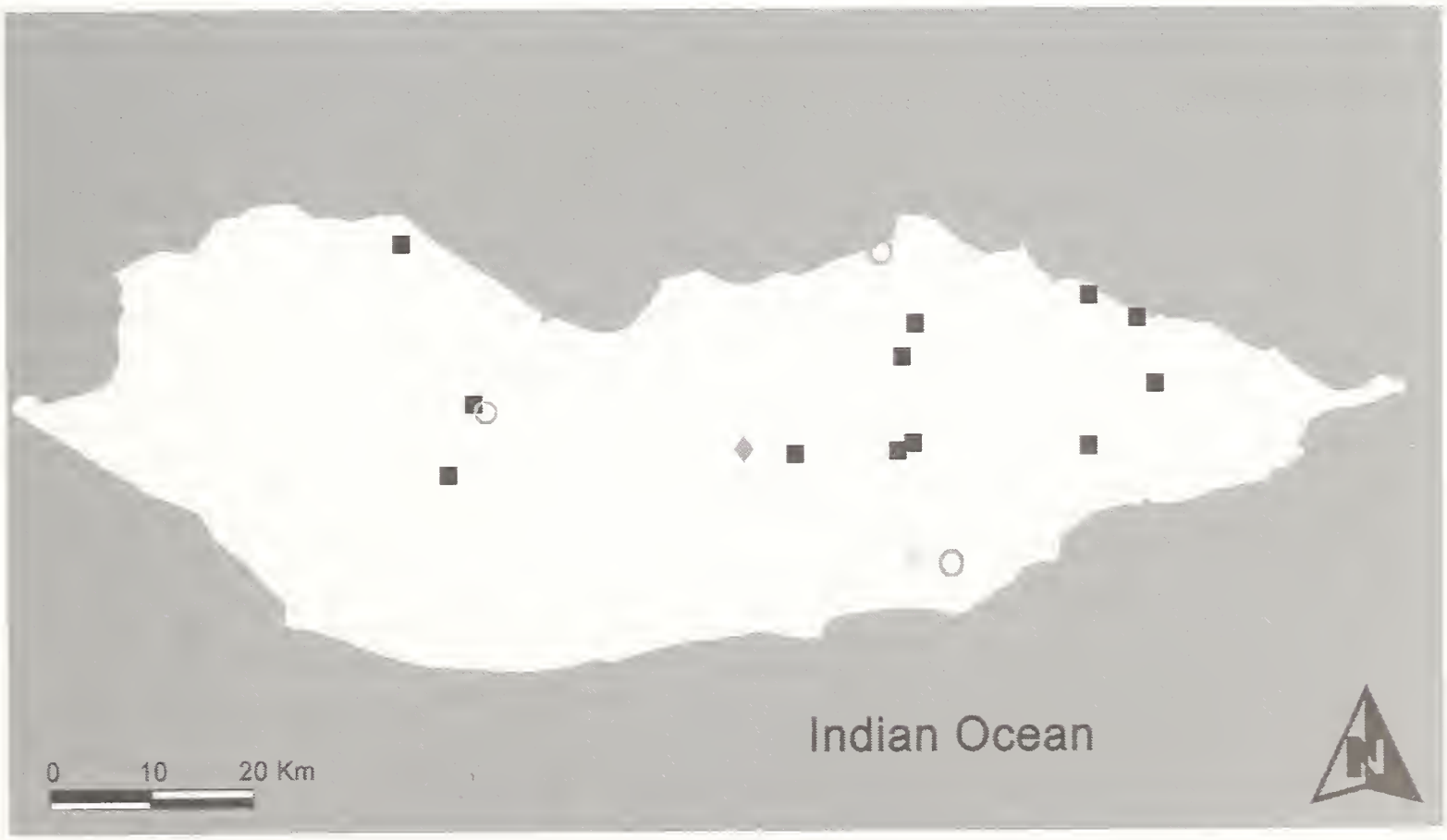

Fig. 1 - Bat roosts and sites monitored in Socotra Island (Roost e altri siti cesiti nell'isola di Socotra). ■ *Rhinopoma hardwickii;* ○ *Asellia tridens;* ▲ *Rhinopoma hardwickii* and *Asellia tridens;* ♦ *Rhinolophus clivosus.*

Tab. 1 - Roosts and resting sites found inhabited by bats during the monitoring field work. *R.h.= Rhinopoma hardwickii; A.t.= Asellia tridens; R.c.= Rhinolophus clivosus.* For each species and site we reported the number of captured bats. "Bat number" indicates the approximate number of bats found inside the site. *R.h.= Relative humidity.* "Use by humans indicates" the sites used by people as dwellings, goat enclosures or stores. "Guano collection" indicates the site where local people use to collect guano. "n.d." = not determined.

Tab. 1 - *Roosts* e *resting sites* verificati nel corso dei rilievi di campo. *R.h.= Rhinopoma hardwickii; A.t.= Asellia tridens; R.c.= Rhinolophus clivosus.* Per ogni specie e stazione vengono riportati il numero di animali catturati complessivamente e per sesso. "Bat number" indica il numero approssimativo di individui presenti all'interno del sito. *R.h.= Umidità relativa.* "Use by humans" indica i siti utilizzati dalla popolazione locale come casa, ovile o magazzino. "Guano collection" indica i siti nei quali la popolazione locale preleva periodicamente il guano all'interno del *roost*. "n.d." = non determinata.

Site (location)	**Date**	***R.h.***	***A.t.***	***R.c.***	**Bat number**	**Temp. (°C)**	**RH**	**Use by humans**	**Guano collection**	**GPS position**
Devegach (Dehasas)	19/8/2003	1♀			4	33.3	70%			n.d.
Shesehar (Shesehar)	19/8/2003	2 (1♂, 1♀)			3	36.6	48%	X		n.d.
Ghelemeneten (Abel)	20/8/2003	6 (1♂, 5♀)			30-40	30.1	54%	X		n.d.
De Qaseqas (Moumi)	24/8/2003	2 (1♂, 1♀)			min 35	30.1	77%			N 12.55538 E 054.30957
Ghelemeneten (Mactinac)	25/8/2003				1	n.d.	n.d.			N 12.53024 E 054.36617
Desberhe (Medhobo)	25/8/2003	4 (3♂, 1♀)			15-20	27.9	66%	X	X	N 12.40130 E 054.25192
Qatanen I (De Fareho)	27/8/2003	3 (2♂, 1♀)			30-40	30.4	56%	X	X	N 12.53406 E 053.71129
Qatanen II (De Fareho)	27/8/2003		9 (4♂,5♀)		500-600	33.4	77%		X	N 12.53240 E 053.71328

Site (location)	Date	*R.h.*	*A.t.*	*R.c.*	Bat number	Temp. (°C)	RH	Use by humans	Guano collection	GPS position
Halolaighan (Lahas)	27/8/2003	3 (1♂, 2♀)			25-50	30.4	60%	X		N 12.47459 E 053.68332
Rhahr (Hawlaf)	29/8/2003		5 (3♂,2♀)		500-600	33.4	78%		X	N 12.67032 E 054.06894
Terbak (Shab)	3/9/2003	3 (2♂, 1♀)			8	27.9	66%			N 12.49252 E 054.08278
Hovagh (Shab)	3/9/2003	5 (3♂, 2♀)			20-25	28.9	67%			N 12.49378 E 054.08997
Gorf (Haif)	3/9/2003	3♀	3♀		min 250	29.0	67%			N 12.39879 E 054.09682
Hafur Cave (Diksam)	8/9/2003			1♂	3	21.9	89%	X		N 12.49836 E 053.94602
Jalad (Shibhon)	8/9/2003	5 (3♂, 2♀)			min 50	25.1	75%			N 12.49296 E 053.99186
Reshom (Haggher)	14/9/2003	4 (2♂, 2♀)			60-80	29.9	50%			N 12.60565 E 054.99698
Shesor (Haggher)	15/9/2003	5 (4♂, 1♀)			min 20	n.d.	n.d.			N 12.57678 E 054.08685

We also visited three sites at which we did not find any bats, although they were previously indicated as bat roost:

- A small cave on the border of Wadi Ghelemeneten (translation: Bat's River) in Hadibo previously hosted a colony of bats, probably Rhinopomatids considering the characteristics of the cave. We did not find evidence suggesting the recent presence of bats.
- A cave on the hill close to the port of Howlaf has also hosted a colony in the past (Ahmed Saeid Suleiman pers. com.), again probably Rhinopomatids considering the characteristics of the cave. We found just an old trace of a previous colony on the ceiling.
- In a small cave on the border of Qaryha Lagoon we found signs of a quite recent bat presence on the ceiling, and guano on the floor. It had been quite a large colony and moved from the site no more than a few months before the survey.

Species account

Family Rhinopomatidae

***Rhinopoma hardwickii* Gray, 1831**

In total we visited 13 sites used by *Rhinopoma hardwickii*. At least 8 of them can be considered most likely to be reproductive colonies. The minimum numbers of *R. hardwickii* for each site varied from 3 to 100 ca. (Gorf Cave). Only once in Gorf Cave (Noged) did we find *R. hardwickii* using the same site with another species (*Asellia tridens)*.

R. hardwickii demonstrates an impressive adaptability in selecting roost site. We found *R. hardwickii* in large caves (De Qaseqas), tunnel systems (Wadi Zaerig), small caves, crevices between large rocks, and man-made buildings.

Even the conditions inside the roosts showed a fair variability. The temperatures ranged from 25.1 to 36.6 °C, and the range of relative humidity varied from 48 to 77%. We found colonies in almost every monitored area of the island, and in all the main different environments. A colony in the Hagger Mountains was approximately at 1,000 m a.s.l.. However, the roosts appear more widespread at lower altitudes. Five sites were used by humans as stores or goat enclosures (Fig. 2), and in three of these people even made fires inside the site, in order to sterilize the milk of their goats. In two sites the guano was collected by people to be used as fertilizer for their vegetable gardens.

We captured 46 (23 ♂, 23 ♂) *R. hardwickii,* at least one for each monitored site. The results of morphometrical measurements are summarised up in Tab. 2.

Family Hipposideridae

***Asellia tridens* (E. Geoffroy, 1813)**

Collectively, we visited 3 sites used by *Asellia tridens*. All of them can be considered most likely to be reproductive colonies. The roost in Gorf Cave is a mixed colony with *R. hardwickii.* The colonies of Rhahr and De Fareho were composed of at least 500 individuals.

The entrance of the roost hall is always less then 1-1.5 m^2, and inside it is com-

Fig. 2 - The cave of Ghelemeneten (Abel). The cave is used by local people as goat enclosure.
Fig. 2 - La cavità naturale di Ghelemeneten in località Abel. La cavità viene impiegata dalla popolazione locale come ovile.

pletely dark with no filtering light. The range of temperatures varies between 29.0 and 33.4 °C, and the range of relative humidity varied from 67 to 78%. The caves used by *A. tridens* were not-man made; however, they were not underground wadis. All three colonies found are located below 80 m a.s.l. and placed on hills not far (maximum 600 m) from semi-arid woodland plains. In the sites of Rhahr and De Fareho the guano is collected by the people for their vegetable gardens or for profit.

We captured a total of 18 (7♂, 11♂) *A. tridens*, while sampling every site. One female was captured in Chesa (Noged) by mistnetting in open space; this specimen is not included in Tab.1, but its morphometrical measurements are summarized in Tab. 2.

Family Rhinolophidae

***Rhinolophus clivosus* Cretzschmar, 1828**

We recorded this species once, a solitary male, in Hafur Cave, Diksam plateau (Fig. 3). In its noseleaf, the superior connecting process of the sella is elevated into a blunt point, when viewed laterally (Fig. 3). It corresponds closely to the illustration of the sella of *R. clivosus* from Yemen in Harrison & Bates (1991, Fig. 59b). We also observed two flying bats in the huge cave, but the identification of the species was impossible. The morphometrical measurements of this specimen are shown in Tab. 2.

Fig. 3 - Lateral view of the sella in *Rhinolophus clivosus*.
Fig. 3 - Profilo della sella di *Rhinolophus clivosus*.

Tab. 2 - Comparison of body length, tail and forearm between the specimens captured in the present study and those of previous studies conducted in the Arabian and Middle East region. HB=Length of head and body; T=Length of tail; FA=Length of forearm; SD=Standard Deviation.
Tab. 2 - Confronto dei dati morfometrici (avambraccio, testa-corpo, coda) ottenuti dalle misurazioni effettuate nel corso del presente studio e quelle ottenute nell'ambito di precedenti studi condotti nella penisola Arabica e in Medio Oriente. HB=Lunghezza testa-corpo; T=Lunghezza della coda; FA=Lunghezza dell'avambraccio; SD=Deviazione Standard.

Species	Author	Locality	HB				T				FA			
				SD	min	max		SD	min	max		SD	min	max
Rhinopoma hardwickii	Cesarini, 2006	Socotra (Yemen)	121.8 (n=43)	9.4	98	138	64.9 (n=43)	6.8	49	78	57.4 (n=46)	3.2	50	63
Rhinopoma hardwickii	Wranik et al., 1991	South Yemen	119.5 (n=4)	3.4	116	124	57.8 (n=5)	4.1	53	62	54.4 (n=5)	1.3	53	56
Rhinopoma hardwickii	Harrison & Bates, 1991	Israel, Jordan, Yemen, Saudi Arabia and Oman	121.9 (n=85)	8.7	101	144	62.9 (n=88)	5.4	46	73	55.5 (n=94)	2.3	47	59
Asellia tridens	Cesarini, 2006	Socotra (Yemen)	70.5 (n=18)	2.6	64	74	19.1 (n=18)	1.5	17	22	46.5 (n=18)	1.5	44	50
Asellia tridens	Wranik *et al.*, 1991	Socotra (Yemen)	62.5 (n=2)	-	62	63	16.5 (n=2)	-	16	17	45.0 (n=2)	-	-	-
Asellia tridens	Wranik *et al.*, 1991	South Yemen	73.3 (n=4)	4.8	67	77	20.3 (n=4)	1.5	19	22	51.0 (n=4)	1.2	50	53
Asellia tridens	Harrison & Bates, 1991	Israel, Iraq, Oman, U.A.E., Saudi Arabia and Yemen	77.9 (n=77)	5.8	61	90	22.2 (n=86)	3.0	16	29	50.7 (n=91)	2.1	43	56
Rhinolophus clivosus	Cesarini, 2006	Socotra (Yemen)	75	-	-	-	25	-	-	-	46	-	-	-
Rhinolophus clivosus clivosus	Harrison & Bates, 1991	North-western Saudi Arabia and Israel	79.5 (n=10)	3.6	74	83	27.8 (n=15)	3.6	19	33	47.1 (n=15)	1.7	45	50
Rhinolophus clivosus acrotis	Harrison & Bates, 1991	Southern Saudi Arabia and Yemen	87.4 (n=17)	4.5	77	95	32.3 (n=17)	3.5	25	38	50.3 (n=18)	1.2	47	53

Discussion

We monitored three species in the island: *Rhinopoma hardwickii, Asellia tridens* and *Rhinolophus clivosus*. From a global conservationist point of view these species are not considered as endangered and their distribution is widespread. The Socotran populations of *R. hardwickii* and *A. tridens* seem to be in good conservation status, both for consistency and distribution. *R. clivosus* is a typical African bat widespread on the continent, but also present in the western part of the Arabian Peninsula (Harrison & Bates, 1991). There are several records for this species in Yemen (Hayman & Harrison, 1950; Sanborn & Hoogstraal, 1953; Harrison, 1964; Kock & Nader, 1979; Nader, 1982; Kock *et al.,* 2002), but our record seems to be the first one for this species in Socotra (Al-Jumaily, 1998). Probably this and another record from Oman (Snowden *et al.*, 2000), represent the eastern limit of its distribution. For this reason the presence of *R. clivosus* in the archipelago could be unstable or weak.

Concerning *Rhinopoma hardwickii* we verified a high adaptability in the roost site selection. Previous observation of this species suggested this and, in addition, the inclination to build colonies of smaller size compared with other species (Nader, 1975; Atallah, 1977). Its proximity to humans is particularly interesting. In many areas of the island people habitually collect guano from the colonies for personal use or it is sold for use as a powerful fertilizer in vegetable gardens. Moreover, people of Socotra frequently use natural caves or sites for their own activities, located even in the most inhospitable areas. Such confidence with humans shown by *R. hardwickii* is probably one of the main reasons for its success in the colonization of the island.

The morphometrical analyses of the Socotran population of *R. hardwickii* do not show any particular inconsistencies with the results obtained by Harrison & Bates (1991) for a larger and widespread population in Arabia (Tab. 2.).

Otherwise, the Socotran population of *A. tridens* seems to have morphological measurements (forearm, body length and tail) on average shorter than the specimens of the species mentioned by Harrison & Bates (1991), but nevertheless almost within the species range. Such a result, confirms that this species shows evident variations between different populations (Gaisler *et al.*, 1972; Wranik *et al.*, 1991). A morphometrical analysis conducted on a limited sample of specimens from Socotra and South Yemen (Wranik *et al.*, 1991) showed that the two specimens from Socotra Island were smaller than those from the mainland. Our study seems to confirm these results. The 18 individuals captured by us show forearm, body length and tail on average smaller than the Arabian widespread population studied by Harrison & Bates (1991) and the specimens from southern Yemen (Wranik *et al.*, 1991). The partial isolation of the bats on the island could establish the conditions for a genetic segregation of their populations.

Furthermore, interesting evidence was obtained on the roost site selection in *A. tridens*. The data clearly indicates an ecological set of criteria adopted by this species. Our findings seem to confirm previous studies involving *A. tridens* that indicated dry caves were often occupied by hundreds bats as the most common roost type for this species (DeBlase, 1980; Harrison & Bates, 1991).

Very little ecological and morphological hypotheses can be put forward regarding *Rhinolophus clivosus* with our limited sample. However that we found the bat

in a large cave is a point of interest as this species in generally considered to predominantly use building or other man-made constructions for its roost site (Sandborn & Hoogstraal, 1953; Wassif, 1953; Nader, 1982).

Another interesting issue is the identity of the subspecies of *R. clivosus* that we captured in Socotra. Looking at Tab. 2 it is evident that its morphometrical measurements are closer to the northern subspecies (*Rhinolophus clivosus clivosus,* Israel and northern Saudi Arabia), and partially below the minimum in the range of variability of the southern subspecies (*Rhinolophus clivosus acrotis,* southern Saudi Arabia and Yemen). The data should be confirmed by further sampling of this species in the island.

Our data shows that there is minimum overlap within these three species at their roost sites. Only once two of them occupied the same site (*Asellia tridens* and *Rhinopoma hardwickii* in Gorf Cave).

Seasonal movements of colonies inside the main island are possible and probable. Our data on abandoned roosts seems to confirm this hypothesis.

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